# Regulatory Analysis for Generic Letter 2004-02: Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors

**U.S. Nuclear Regulatory Commission**
Office of Nuclear Reactor Regulation

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# EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) is issuing Generic Letter 2004-02 to request that all pressurized-water reactor (PWR) licensees, as specified, perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions and, if appropriate, implement any corrective actions that the evaluation identifies as being necessary to ensure system functionality. In addition, PWR licensees are requested to submit information to the NRC to confirm compliance with the regulatory requirements outlined in the generic letter. The actions and information requested in the generic letter are based on the identified potential susceptibility of PWR recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of the ECCS or CSS, the potential for adverse effects due to debris blockage of flow paths necessary for ECCS and CSS recirculation and containment drainage, and the potential adverse effects of chemical precipitants on head loss. All PWR licensees are required to provide the NRC a written response in accordance with 10 CFR 50.54(f).

This regulatory analysis evaluates the values and impacts associated with the two regulatory alternatives considered by the NRC to address the PWR sump performance issue:

- *Option 1: No Action.* Under the no-action alternative, the NRC would not require PWR licensees to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids.

- *Option 2: Generic Letter.* Under the generic letter alternative, the NRC will require PWR licensees to (1) perform an evaluation of the ECCS and CSS recirculation functions, (2) implement any corrective actions (e.g., reactor-specific modifications) that the evaluation identifies as being necessary to ensure system functionality, and (3) submit information that confirms plant-specific compliance with the regulatory requirements outlined in the generic letter.

The no-action alternative is the default approach if Option 2 is not the preferred alternative. Its primary function is to establish the baseline condition from which the incremental values and impacts associated with the generic letter alternative are calculated.

The NRC estimated the incremental costs to industry and the NRC under Option 2. Because the number of operating PWRs that will require reactor-specific modifications under the generic letter is unknown, the NRC assumed a low estimate of 25 PWRs and a high estimate of 37 PWRs. These estimates are based on work performed by Los Alamos National Laboratory (LANL) on Generic Safety Issue-191. The incremental costs under Option 2 were estimated using low and high cost estimates for reactor-specific modifications. All costs incurred in the future were calculated in 2004 dollars using discount rates of 7 and 3 percent. The results are presented in Table ES-1.

**Table ES-1**
**Present Value of the Total Costs Under Option 2, the Generic Letter Alternative[a, b]**
(2004 dollars in millions)

| Discount Rate | 25 Plant Case[c] | 37 Plant Case[d] |
|---|---|---|
| **Low-Cost Reactor-Specific Modification** | | |
| 7% | $2.4 | ($13.1) |
| 3% | ($50.0) | ($81.2) |
| **High-Cost Reactor-Specific Modification** | | |
| 7% | $89.1 | $115.2 |
| 3% | $47.2 | $62.7 |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.

As shown in Table ES-1, for the low-cost reactor-specific modification, the net present value under Option 2, using a 7 percent discount rate, is estimated to range from a cost of $2.4 million to a savings of $13.1 million. Using a 3 percent discount rate, the net present value is estimated to range from a savings of $50 million to a savings of $81.2 million. Thus, for the low-cost reactor-specific modification, the net present value under Option 2 is estimated to range from a cost of $2.4 million to a savings of $81.2 million.

For the high-cost reactor-specific modification, the net present value under Option 2, using a 7 percent discount rate, is estimated to range from a cost of $89.1 million to $115.2 million. Using a 3 percent discount rate, the net present value is estimated to range from a cost of $47.2 million to a cost of $62.7 million. Thus, for the high-cost reactor-specific modification, the net present value under Option 2 is estimated to range from a cost of $47.2 million to a cost of $115.2 million.

Although the quantitative benefits do not outweigh the quantitative costs under Option 2 in all instances, Option 2 was determined to be the preferred option because it is expected to (1) enhance regulatory efficiency (by establishing a procedure that PWR licensees may use to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids), (2) improve the current understanding of ECCS and CSS recirculation capabilities at PWR facilities, (3) improve public health and safety, and (4) increase public confidence.

The NRC believes the incremental costs to licensees and the NRC under Option 2 are justified because the requested actions and information are necessary to verify plant-specific compliance with existing regulatory requirements and, thus, ensure adequate public protection.

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## 1. Introduction

The U.S. Nuclear Regulatory Commission (NRC) is issuing Generic Letter 2004-02 to request that all pressurized-water reactor (PWR) licensees, as specified, perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions and, if appropriate, implement any corrective actions that the evaluation identifies as being necessary to ensure system functionality. In addition, PWR licensees are requested to submit information to the NRC to confirm compliance with the regulatory requirements outlined in the generic letter. The actions and information requested in the generic letter are based on the identified potential susceptibility of PWR recirculation sump screens to debris blockage during design basis accidents requiring recirculation operation of the ECCS or CSS, the potential for adverse effects due to debris blockage of flow paths necessary for ECCS and CSS recirculation and containment drainage, and the potential adverse effects of chemical precipitants on head loss. All PWR licensees are required to provide the NRC a written response in accordance with 10 CFR 50.54(f).[1]

The NRC considered two alternatives to address the PWR sump performance issue. The purpose of this regulatory analysis is to evaluate the values and impacts associated with these two regulatory alternatives. The NRC considers the regulatory analysis process an integral part of its statutory mission to ensure adequate protection of public health and safety, to promote the common defense and security, and to protect the environment from civilian uses of byproduct, source, and special nuclear materials. This document presents background material, describes the objectives of the regulatory action, outlines the alternatives considered by the NRC, and evaluates the values and impacts of the regulatory alternatives.

### 1.1 Background

In 1979, as a result of evolving staff concerns about the adequacy of PWR recirculation sump designs, the NRC opened Unresolved Safety Issue (USI) A-43, "Containment Emergency Sump Performance." To support the resolution of USI A-43, the NRC undertook an extensive research program, the technical findings of which are summarized in NUREG-0897, "Containment Emergency Sump Performance," dated October 1985. The resolution of USI A-43 was subsequently documented in Generic Letter 85-22, "Potential for Loss of Post-LOCA Recirculation Capability Due to Insulation Debris Blockage," dated December 3, 1985. Although the staff's regulatory analysis concerning USI A-43 did not support imposing new sump performance requirements upon licensees of operating PWRs or boiling-water reactors (BWRs), the staff found in Generic Letter 85-22 that the 50-percent blockage assumption (under which most nuclear power plants had been licensed) identified in Regulatory Guide 1.82, "Sumps for Emergency Core Cooling and Containment Spray Systems," Revision 0 should be replaced with a more comprehensive requirement to assess debris effects on a plant-specific basis. The 50-percent screen blockage assumption does not require a plant-specific evaluation of the debris-blockage potential and may result in a nonconservative analysis for screen

[1] Under 10 CFR 50.54(f), licensees must at any time before expiration of their license, upon request of the Commission, submit as specified in section 50.4, written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked.

blockage effects. The staff also updated the NRC's regulatory guidance, including Section 6.2.2 of the Standard Review Plan (NUREG-0800) and Regulatory Guide 1.82 to reflect the USI A-43 technical findings documented in NUREG-0897.

Following the resolution of USI A-43 in 1985, several events challenged the conclusion that no new requirements were necessary to prevent the clogging of ECCS strainers at operating BWRs:

- On July 28, 1992, at Barsebäck Unit 2, a Swedish BWR, the spurious opening of a pilot-operated relief valve led to the plugging of two containment vessel spray system suction strainers with mineral wool and required operators to shut down the spray pumps and backflush the strainers.

- In 1993, at Perry Unit 1, ECCS strainers twice became plugged with debris. On January 16, ECCS strainers were plugged with suppression pool particulate matter and, on April 14, an ECCS strainer was plugged with glass fiber from ventilation filters that had fallen into the suppression pool. On both occasions, the affected ECCS strainers were deformed by excessive differential pressure created by the debris plugging.

- On September 11, 1995, at Limerick Unit 1, following a manual scram due to a stuck-open safety/relief valve, operators observed fluctuating flow and pump motor current on the A loop of suppression pool cooling. The licensee later attributed these indications to a thin mat of fiber and sludge which had accumulated on the suction strainer.

In response to these ECCS suction strainer plugging events, the NRC issued several generic communications, including Bulletin 93-02, Supplement 1, "Debris Plugging of Emergency Core Cooling Suction Strainers," dated February 18, 1994; Bulletin 95-02, "Unexpected Clogging of a Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode," dated October 17, 1995; and Bulletin 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," dated May 6, 1996. These bulletins requested that BWR licensees implement appropriate procedural measures, maintenance practices, and plant modifications to minimize the potential for the clogging of ECCS suction strainers by debris accumulation following a loss-of-coolant accident (LOCA). The NRC staff has concluded that all BWR licensees have sufficiently addressed these bulletins.

However, findings from research to resolve the BWR strainer clogging issue raised questions concerning the adequacy of PWR sump designs. In comparison to the technical findings of the earlier USI A-43 research program on PWRs, the BWR research findings demonstrate that the amount of debris generated by a high-energy line break (HELB) could be greater, that the debris could be finer (and, thus, more easily transportable), and that certain combinations of debris (e.g., fibrous material plus particulate material) could result in a substantially greater head loss than an equivalent amount of either type of debris alone. These research findings prompted the NRC to open Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance." The objective of GSI-191 is to ensure that post-accident debris blockage will not impede or prevent the operation of the ECCS and CSS in recirculation mode at PWRs during LOCAs or other HELB accidents for which sump recirculation is required.

On June 9, 2003, having completed its technical assessment of GSI-191, the NRC issued Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Recirculation During Design-Basis Accidents at Pressurized-Water Reactors." As a result of the emergent issues discussed therein, the bulletin requested an expedited response from PWR licensees on the status of their compliance on a mechanistic basis with regulatory requirements concerning the ECCS and CSS recirculation functions. Addressees who chose not to confirm regulatory compliance were asked to describe any interim compensatory measures that had been implemented or would be implemented to reduce risk until the analysis could be completed. All licensees have since responded to Bulletin 2003-01. In developing Bulletin 2003-01, the NRC staff recognized that it might be necessary for addressees to undertake complex evaluations to determine whether regulatory compliance exists in light of the concerns identified in the bulletin and that the methodology needed to perform such evaluations was not currently available. As a result, information on regulatory compliance was not requested in the bulletin, but addressees were informed that the staff was preparing a generic letter that would request that information. Generic Letter 2004-02 is the follow-on information request referenced in the bulletin.

## 1.2 Objectives of the Regulatory Action

Based on the new information identified during the efforts to resolve GSI-191, the NRC staff has determined that the previous guidance used to develop current licensing basis analyses does not adequately and completely model sump screen debris blockage and related effects. The deficiencies in the previous guidance potentially result in analytical errors that could cause ECCS performance that does not conform with the existing applicable regulatory requirements outlined in the generic letter. Therefore, the staff is revising its guidance for determining the susceptibility of PWR recirculation sump screens to the adverse effects of debris blockage during design basis accidents requiring recirculation operation of the ECCS or CSS.

In light of the revised staff guidance, the NRC staff has determined that it is appropriate to request that PWR licensees perform new, more realistic analyses and submit information to confirm the functionality of the ECCS and CSS during design basis accidents requiring recirculation functions. This information is necessary to verify licensees' compliance with the regulatory requirements outlined in the generic letter once their licensing basis has been updated to reflect the results of the mechanistic analysis requested in the generic letter.

The NRC staff also will use the requested information to (1) determine whether a sample auditing approach is acceptable for verifying that PWR licensees have resolved the concerns identified in the generic letter, (2) assist in determining which PWR licensees would be subject to the proposed sample audits, (3) provide confidence that any unaudited licensees have addressed the concerns identified in the generic letter, and (4) assess the need for and guide the development of any additional regulatory actions that may be necessary to address the adequacy of the ECCS and CSS recirculation functions.

## 2. Identification and Preliminary Analysis of Alternative Approaches

This regulatory analysis evaluates the values and impacts of two regulatory alternatives. The following subsections describe these two alternatives.

### 2.1 Option 1: No Action

Under the no-action alternative, the NRC would not require PWR licensees to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids.

### 2.2 Option 2: Generic Letter

Under the generic letter alternative, the NRC will require PWR licensees to (1) perform an evaluation of the ECCS and CSS recirculation functions, (2) implement any corrective actions (e.g., reactor-specific modifications) that the evaluation identifies as necessary to ensure system functionality, and (3) submit information that confirms plant-specific compliance with the regulatory requirements outlined in the generic letter.

In particular, the generic letter will require PWR licensees to submit the following information:

- Within 90 days of the date of the safety evaluation report providing the guidance for performing the requested evaluation, provide a written response to the NRC with information regarding their planned actions and schedule to complete the requested evaluation.

- No later than September 1, 2005, provide a written response to the NRC with information that confirms compliance with the regulatory requirements outlined in the generic letter once their licensing basis has been updated to reflect the results of the mechanistic analysis requested in the generic letter.

Both written responses must include the information specified in the Requested Information section of the generic letter.

## 3. Analysis of Values and Impacts

The three subsections below describe the analysis conducted to identify and evaluate the values and impacts expected to result from Generic Letter 2004-02. Subsection 3.1 identifies the attributes that the generic letter is expected to affect. Subsection 3.2 describes the methodology used to analyze the values and impacts associated with the generic letter. Subsection 3.3 discusses the results of the analysis.

### 3.1 Identification of Affected Attributes

This subsection identifies the attributes, within the public and private sectors, that Generic Letter 2004-02 is expected to affect, using the list of potential attributes provided in Chapter 5 of NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," dated January 1997. Each attribute listed in Chapter 5 was evaluated. The basis for selecting those attributes expected to be affected by the generic letter is presented below.

Generic Letter 2004-02 is expected to affect the following attributes:

- *Public and Occupational Health (Accident)*. The generic letter will require PWR licensees to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids. Based on their findings, licensees may need to implement corrective actions (e.g., reactor-specific modifications) as necessary to ensure compliance with all applicable regulatory requirements. Implementation of these corrective actions should ensure that debris blockage does not impede or prevent the operation of ECCS and CSS in recirculation mode during LOCAs for which sump recirculation is required. As a result, the regulatory action is expected to avert potential radiation exposure to the public and site workers following LOCAs.

- *Offsite Property*. As stated above, based on the results of their analysis of the susceptibility of the ECCS and CSS recirculation functions under debris loading conditions, licensees may need to implement corrective actions at their facilities. Implementation of these corrective actions is expected to avert potential offsite property damage and costs (e.g., long-term relocation, emergency response) that may follow LOCAs.

- *Onsite Property*. Implementation of corrective actions under the regulatory action also is expected to avert potential onsite property damage and costs (e.g., cleanup and decontamination, replacement power) that may follow LOCAs.

- *Industry Implementation*. The regulatory action will require licensees to (1) perform an evaluation of the ECCS and CSS recirculation functions, (2) implement any corrective actions (e.g., reactor-specific modifications) that the evaluation identifies as necessary to ensure system functionality, and (3) submit information that confirms plant-specific compliance with the regulatory requirements outlined in the generic letter.

- *NRC Implementation*. To implement the regulatory action, the NRC will review information submitted by licensees, develop guidance for performing the regulatory compliance evaluation, conduct audits and inspections to verify compliance with applicable regulatory requirements, and conduct additional research on the adequacy of the ECCS and CSS recirculation functions.[2]

- *Improvements in Knowledge*. The regulatory action will require licensees to analyze the susceptibility of the ECCS and CSS recirculation functions under debris loading conditions. The results of these analyses are expected to improve the current understanding of ECCS and CSS recirculation capabilities at PWR facilities.

- *Regulatory Efficiency*. The regulatory action will enhance regulatory efficiency by establishing staff-approved guidance that PWR licensees may use to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids. Consequently, licensees and the NRC will face less uncertainty in determining compliance with the regulatory requirements outlined in the generic letter.

- *Other Considerations*. The regulatory action will require licensees to analyze the susceptibility of the ECCS and CSS recirculation functions under debris loading conditions. Based on their findings, licensees may need to implement corrective actions (e.g., reactor-specific modifications) as necessary to ensure compliance with the regulatory requirements outlined in the generic letter. Implementation of these corrective actions is expected to ensure the continued health and safety of the public. As a result, the regulatory action may increase public confidence in PWR facilities and the NRC.

Generic Letter 2004-02 is *not* expected to affect the following attributes:

- Public Health (Routine)
- Occupational Health (Routine)
- Industry Operation
- NRC Operation
- Other Government
- General Public
- Antitrust Considerations
- Safeguards and Security Considerations
- Environmental Considerations

### 3.2 Methodology

This subsection describes the methodology used to analyze the values and impacts associated with Generic Letter 2004-02. The values include any desirable changes in the affected attributes, while the impacts include any undesirable changes in the affected attributes.

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[2] Consistent with direction in Section 5.7.9 of NUREG/BR-0184, this analysis does not include the pre-decisional costs of analyzing issues associated with PWR pump performance and issuing the generic letter.

This analysis relies on both a quantitative and a qualitative analysis of the affected attributes. The quantitative analysis involves the assessment of values (savings) and impacts (costs) under the generic letter. The qualitative analysis involves a discussion of those attributes that the NRC was not able to quantify.

The balance of this subsection describes the most significant analytical data and assumptions used in the quantitative analysis of the affected attributes.

### 3.2.1 Baseline for Analysis

The analysis measures the incremental values and impacts of the generic letter relative to a baseline (Option 1, the no-action alternative), which is how the world would be in the absence of the generic letter.

### 3.2.2 Affected Universe

There are 69 PWRs currently in operation. However, the NRC is uncertain about the number of operating PWRs that will require corrective actions under the generic letter.

### 3.2.3 Analysis of Values

In analyzing the quantifiable values associated with Generic Letter 2004-02, the staff referred to NRC's "Risk and Cost-Benefit Considerations Associated with GSI-191, Assessment of Debris Accumulation on PWR Sump Performance, Rev. 1" (September 21, 2001).[3] This report examines the risks associated with accident sequences involving sump screen clogging in PWRs. In particular, it examines the monetized benefits associated with completely eliminating accidents associated with sump screen clogging.

Subsection 3.2.3.1 provides an overview of the analytical data and assumptions used to estimate the monetized benefits in the September 2001 report. Subsection 3.2.3.2 discusses how the NRC staff used the data and assumptions in the September 2001 report to estimate the monetized benefits under the generic letter alternative.

#### 3.2.3.1 Overview of Analytical Data and Assumptions in the September 2001 Report

The September 2001 report estimates the expected averted monetized costs (i.e., monetized benefits) associated with completely eliminating accidents associated with sump screen clogging. The report assumes that these accidents can be completely eliminated by making reactor-specific modifications.

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[3] This report is included as Attachment 3 of NRC Memorandum "RES Proposed Recommendation for Resolution of GSI-191, Assessment of Debris Accumulation on PWR Sump Performance" (September 28, 2001). Both the NRC Memorandum and Attachment 3 are available in ADAMS. The memorandum's Document Accession No. is ML012750091; the attachment's Document Accession No. is ML012750414.

The September 2001 report estimates the monetized benefits for (1) various combinations of probabilities of sump screen clogging, (2) various size LOCAs (i.e., large, medium, small, and reactor coolant pump seal LOCA), and (3) different containment types (i.e., large dry, subatmospheric, and ice condenser). The benefits considered include:

- the expected averted population dose
- the expected averted onsite occupational dose
- the expected averted onsite financial costs
- the expected averted offsite financial costs

The benefits depend on the years of remaining life of the PWR for which the reactor-specific modification has been made. The longer the remaining life of the PWR, the longer the PWR will benefit from making the modifications. The report assumed that the reactor-specific modification would be in place in 3 years (i.e., in 2004), when the average remaining license period for a PWR, without license renewal, would have been 14 years. With a 20-year license renewal period, the average remaining life would be 34 years (in 2004). The report therefore estimates the monetized benefits for several remaining lifetimes, ranging from 14 to 34 years.

Following is a brief description of the analytical data and assumptions used in the September 2001 report to estimate the monetized benefits.

- *Averted Population Dose.* The September 2001 report estimates the averted population dose within a 50-mile radius of the plant site, assuming that the monetary value of a unit of radiation exposure is $2,000 per person-rem. This is consistent with guidance in Section 5.7.1 of NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," dated January 1997.

  The September 2001 report uses population dose data given for the Zion site in Table 5.3 of NUREG/BR-0184. The data for the Zion site in this table does not use the actual population density around the Zion site, but rather an $80^{th}$ percentile population density. The particular values taken from Table 5.3 of NUREG/BR-0184 were for a LOCA. The report indicates that the calculations done for Table 5.3 of NUREG/BR-0184 were based on models used in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," dated 1991. The report also indicates that the dominant LOCA in the NUREG-1150 calculations for the Zion site was that which arose from a loss of component cooling water with consequential reactor coolant pump seal LOCA and loss of high-pressure injection. In such a sequence, the reactor cavity is not filled at the time of vessel breach, and the radioactive source term may be larger (because of less scrubbing of the radioactive releases by the reactor cavity water) than if the failure occurred during recirculation, with more water in the reactor cavity. The report indicates that this is a conservative approximation.

  The September 2001 report assumes a 0.02 probability of early containment failure. This value was obtained by estimating the probability of early containment failure as 0.05 for a sequence where vessel breach occurs with the reactor vessel internal pressure high (> 200 psi), and as 0.01 for a sequence where the reactor vessel

pressure at vessel breach was low (< 200 psi). In addition, the report assumes a 0.20 probability of vessel breach at high pressure. This corresponds to the NUREG-1150 estimate for a small-break LOCA. The September 2001 report indicates that this is a conservative approximation, since there are substantial contributions of large and medium LOCAs to the core damage frequency associated with sump screen clogging.

- *Averted Onsite Occupational Dose.* The September 2001 report indicates that the averted onsite occupational dose were estimated following the guidelines in NUREG/BR-0184. The best estimate immediate dose (per accident) is 3,300 person-rem, and the best estimate long-term dose (per accident) is 20,000 person-rem. The long-term dose is spread over a 10-year period after an accident.

- *Averted Onsite Financial Costs.* The September 2001 report estimates the averted onsite financial costs associated with cleanup, decontamination, and replacement power. For cleanup and decontamination costs, the report uses cost information given on page 5.42 of NUREG/BR-0184: $1.5E9 per accident, in 1993 dollars. These costs were updated to 2001 dollars using a conversion factor of 1.15.[4] The costs were assumed to be spread over 10 years after an accident, and were discounted accordingly, using a 7 percent discount rate.

  For replacement power costs, the report uses formulae for a generic reactor given on page 5.44 of NUREG/BR-0184. The generic reactor is a 910 MWe reactor.

- *Averted Offsite Financial Costs.* The September 2001 report estimates averted offsite financial costs using cost information for the Sequoyah site in NUREG-1150. The report notes that, for purposes of the analysis, cost information in NUREG-1150 was modified to correct errors in the calculation of offsite financial consequences. These errors are discussed in NUREG/CR-4695. The report also notes that the cost information for the Sequoyah site was used, rather than the cost information for the Zion site, for two reasons. First, it was less time consuming to make the changes to the consequence data for the Sequoyah site than for the Zion site. Second, the Zion site may be atypical, if only one calculation is being performed.

  The September 2001 report assumes a probability of early containment failure of 0.02. The report indicates that this is a conservative assumption because of the contribution of large and medium LOCAs where the probability of early containment failure is less. The sequences chosen were LOCA sequences with failure of containment sprays.

[4] Conversion factor obtained from the GDP inflation calculator at http://www.jsc.nasa.gov/bu2/inflateGDP.html.

In estimating the averted offsite financial costs, the September 2001 report used the CRIC-ET code[5], with the offsite financial consequences data modified to correct for the errors in the NUREG-1150 calculation.

The report uses a discount rate of 7 percent to convert future costs to present value (i.e., convert future costs to 2001 dollars).

Based on the above data and assumptions, the September 2001 report estimates the aggregate benefits from averting accidents associated with sump screen clogging for various sets of plants, including:

- *The 25-Plant Case.* This set of plants includes 25 plants that are "very likely" to have the sump screens clogged for all sizes of LOCAs.

- *The 37-Plant Case.* This set of plants includes 37 plants that are (1) "very likely" to have the sump screens clogged for all sizes of LOCAs; (2) "very likely" to have the sump screen clogged for medium and large LOCAs, irrespective of their likelihood of sump screen clogging for small LOCAs; (3) "very likely" to have sump screen clogging for large LOCAs; and (4) "likely" to have sump screen clogging for medium LOCAs. Note that this set of plants includes the 25 plants in the 25-Plant Case.

#### 3.2.3.2 Monetized Benefits Under the Generic Letter Alternative

For the purposes of this regulatory analysis, the NRC staff used the data and assumptions in the September 2001 report to estimate the present value (in 2004 dollars) of the benefits associated with the generic letter, at discount rates of 7 and 3 percent.[6] In doing so, the staff referred to the cost model used in the development of the September 2001 report. The staff then made slight modifications to the cost model in order to:

- Ascertain the monetized benefits at 31 years, the average remaining life of a PWR, with license renewal, in 2007. This is based on the assumption that, in 2007, PWR licensees will make reactor-specific modifications as necessary to ensure compliance with 10 CFR 50.46(b)(5) and other regulatory requirements outlined in the generic letter.

- Estimate the present value (in 2004 dollars) of the monetized benefits, at 7 and 3 percent discount rates.[7]

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[5] See Letter report for FIN L1672, NUREG-1150 Data Base Assessment Program: A Description of the Computational Risk Integration and Conditional Evaluation Tool (CRIC-ET) Software and the NUREG-1150 Data Base, prepared by T.D. Brown, J.D. Johnson, S.L. Humphreys, and J.J. Gregory, Sandia National Laboratories, March 1995.

[6] In developing this regulatory analysis, the NRC staff conducted a sensitivity analysis to account for the uncertainty in monetary value over time. In conducting this analysis, the staff used discount rates of 7 and 3 percent. (See Section 3.2.5 of this document.)

[7] Cost estimates in the cost model were updated to 2004 dollars using an inflation index obtained from the GDP inflation calculator at http://www.jsc.nasa.gov/bu2/inflateGDP.html.

Tables 1 and 2 provide the present value (in 2004 dollars) of the monetized benefits associated with the generic letter for the 25-Plant Case and the 37-Plant Case.

**Table 1**
**Present Value of Monetized Benefits**
**Associated With the Generic Letter, at a 7 Percent Discount Rate**[a, b]
(2004 dollars in millions)

| Plant Set | Offsite Health | Onsite Occupational Dose | Offsite Property | Onsite Property | Total |
|---|---|---|---|---|---|
| 25-Plant Case[c] | $11.0 | $0.8 | $1.7 | $62.3 | $75.8 |
| 37-Plant Case[d] | $14.4 | $1.0 | $2.2 | $81.1 | $98.7 |

[a] Table includes rounding error.
[b] Assumes reactor-specific modifications will be implemented in 2007 and the average remaining life of a PWR license is 31 years in 2007.
[c] Assumes 25 plants will require reactor-specific modifications.
[d] Assumes 37 plants will require reactor-specific modifications.

**Table 2**
**Present Value of Monetized Benefits**
**Associated With the Generic Letter, at a 3 Percent Discount Rate**[a, b]
(2004 dollars in millions)

| Plant Set | Offsite Health | Onsite Occupational Dose | Offsite Property | Onsite Property | Total |
|---|---|---|---|---|---|
| 25-Plant Case[c] | $19.8 | $1.7 | $3.0 | $108.0 | $132.5 |
| 37-Plant Case[d] | $25.8 | $2.2 | $3.9 | $140.0 | $171.9 |

[a] Table includes rounding error.
[b] Assumes reactor-specific modifications will be implemented in 2007 and the average remaining life of a PWR license is 31 years in 2007.
[c] Assumes 25 plants will require reactor-specific modifications.
[d] Assumes 37 plants will require reactor-specific modifications.

### 3.2.4 Analysis of Impacts

This subsection discusses the assumptions used in analyzing the quantifiable impacts (i.e., costs) associated with Generic Letter 2004-02. For purposes of this analysis, the impacts under the generic letter were categorized as follows:

- Regulatory activities
- Evaluation guidance
- Research

- First response to the generic letter
- Second response to the generic letter
- Physical modifications
- Audits and inspections

The cost assumptions for each of the above categories are discussed in the following subsections. Note that all costs presented in this subsection are in 2004 dollars and are based on the assumption that there are 2,000 working hours in a year.

#### 3.2.4.1 Regulatory Activities

In implementing the regulatory action, the NRC expects to perform regulatory and administrative activities (e.g., determine the need for additional regulatory actions, planning, and communications). The NRC estimates that 4.27 person-years of NRC staff time will be required for these activities. Using an estimated average labor rate of $88 per hour for NRC staff, the NRC's cost for regulatory activities is estimated to be $751,520 (i.e., 8,540 hours x $88/hour). For purposes of this analysis, NRC assumes that these costs are spread evenly over a 4-year period (i.e., 2004 through 2007).

#### 3.2.4.2 Evaluation Guidance

The industry has developed generic guidance on how to address the potential of PWR sump blockage post-LOCA. The NRC is currently reviewing this generic guidance, and plans to issue a safety evaluation report endorsing some or all of the generic industry guidance, if found acceptable. Once approved, this guidance may be used to assist PWR licensees in determining the status of regulatory compliance.

Note that the existing evaluation guidance developed by industry does not fully address the effects of the flow paths downstream of the ECCS and CSS (i.e., downstream effects) and the effects of corrosion products on head loss (i.e., chemical effects). Guidance to address these issues has been deferred until additional research is conducted and the data have been appropriately evaluated.

The NRC expects that industry will work on evaluation guidance to address downstream and chemical effects on PWR sump performance. The NRC estimates that industry will require 1 person-year of contractor time for these activities. Using an estimated average labor rate of $157 per hour, industry's cost for developing an evaluation guidance that addresses downstream and chemical effects is estimated to be $314,000 (i.e., 2,000 hours x $157/hour). For purposes of this analysis, NRC assumes that these costs are spread evenly over a 2-year period (i.e., 2004 and 2005).

As stated earlier, the NRC is currently in the process of reviewing generic industry guidance, and intends to document its review in a safety evaluation report. In addition, the NRC expects to participate in the development and review of the evaluation guidance addressing downstream and chemical effects on PWR sump performance. The NRC estimates that 9 person-months of NRC staff time and 9 person-months of contractor support will be required for all of these activities. Using an estimated average labor rate of $88 per hour for NRC staff and $157 per hour for contractor support, the NRC's cost for development and review of evaluation guidance

is estimated to be $367,500 (i.e., [1,500 hours x $88/hour] + [1,500 hours x $157/hour]). For purposes of this analysis, NRC assumes that these costs are spread evenly over a 2-year period (i.e., 2004 and 2005).

#### 3.2.4.3 Research

The NRC expects to conduct additional research on the adequacy of the ECCS and CSS recirculation functions (e.g., research on downstream and chemical effects). The NRC estimates that 3 person-months of NRC staff time and 3.33 person-years of contractor support will be required for these research activities. Using an estimated average labor rate of $88 per hour for NRC staff and $157 per hour for contractor support, the NRC's cost for research activities is estimated to be $1,089,620 (i.e., [500 hours x $88/hour] + [6,660 hours x $157/hour]). For purposes of this analysis, NRC assumes that these costs are spread evenly over a 2-year period (i.e., 2004 and 2005).

#### 3.2.4.4 First Response to Generic Letter - Information on Planned Actions and Schedule To Confirm Compliance With the Regulatory Requirements Outlined in the Generic Letter

The generic letter will require PWR licensees to prepare and submit, within 90 days of the date of the safety evaluation report providing the guidance for performing the requested evaluation, information regarding their planned actions and schedule to complete an evaluation of the susceptibility of the ECCS and CSS recirculation functions of their reactors to adverse effects of post-accident debris blockage and operation with debris-laden fluids. The NRC anticipates that licensees will submit this information in 2004.

The NRC estimates that, on average, 1.32 person-months of licensee staff time and 0.48 person-months of contractor support will be required to prepare and submit the requested information on planned actions and schedule to confirm compliance with 10 CFR 50.46(b)(5) and other existing regulatory requirements for each PWR. Using an estimated average labor rate of $88 per hour for licensee staff and $157 per hour for contractor support, the cost for preparing and submitting this information is estimated to be $31,920 per reactor (i.e., [220 hours x $88/hour] + [80 hours x $157]). Because all 69 operating PWRs are required to submit this information, the industry's cost for preparing and submitting the first response to the generic letter is estimated to be $2,202,480 (i.e., 69 PWRs x $31,920/PWR).

The NRC estimates that 6 person-months of NRC staff time will be required to review and process information submitted for all 69 operating PWRs. Using an estimated average labor rate of $88 per hour for NRC staff, the NRC's cost is estimated to be $88,000 (i.e., 1,000 hours x $88/hour).

#### 3.2.4.5 Second Response to Generic Letter - Information That Confirms Compliance With the Regulatory Requirements Outlined in the Generic Letter

The generic letter will require PWR licensees to prepare and submit, no later than September 1, 2005, information that confirms their compliance with the regulatory requirements outlined in

the generic letter once their licensing basis has been updated to reflect the results of the mechanistic analysis requested in the generic letter. The NRC anticipates that all licensees will submit this information in 2005.

The NRC estimates that, on average, 1.2 person-years of licensee staff time and 2.15 person-years of contractor support will be required to prepare and submit information that confirms compliance with 10 CFR 50.46(b)(5) and other existing regulatory requirements for each PWR. Using an estimated average labor rate of $88 per hour for licensee staff and $157 per hour for contractor support, the cost for preparing and submitting this information is estimated to be $886,300 per reactor (i.e., [2,400 hours x $88/hour] + [4,300 x $157/hour]). Because all 69 operating PWRs are required to submit this information, the industry's cost for preparing and submitting the second response to the generic letter is estimated to be $61,154,700 (i.e., 69 PWRs x $886,300/PWR).

The NRC estimates that 1.5 person-years of NRC staff time and 1 person-year of contractor support will be required to review and process information submitted for all 69 operating PWRs. Using an estimated average labor rate of $88 per hour for NRC staff and $157 per hour for contractor support, the NRC's cost is estimated to be $578,000 (i.e., [3,000 hours x $88/hour] + [2,000 hours x $157/hour]).

#### 3.2.4.6 Physical Modifications

The generic letter will require licensees to analyze the susceptibility of the ECCS and CSS recirculation functions under debris loading conditions. Based on their findings, licensees may need to implement corrective actions (e.g., reactor-specific modifications) as necessary to ensure compliance with the regulatory requirements outlined in the generic letter. For purposes of this analysis, it is assumed that the corrective action to control sump debris for all affected PWRs is a physical modification that increases the area of the sump screen.

For the purposes of this analysis, the NRC adopted high and low estimates of the costs for a reactor-specific modification. The low estimate is $750,000 per reactor.[8] The high estimate is $5 million per reactor.[9] These estimates comprise four broad categories of costs. The first category is engineering and drafting, which covers costs for activities such as drawings, loadings, design packages, and technical specifications. The second category is engineering effort and expenses incurred in developing a mockup and utilizing the mockup to model and test the design against simulated levels of debris. The third category is implementation, which includes mainly labor and material costs for demolition and installation. The fourth category is miscellaneous expenses, which are mainly administrative in nature.

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[8] Based on data obtained from NRC memorandum "RES Proposed Recommendation for Resolution of GSI-191, Assessment of Debris Accumulation on PWR Sump Performance" (September 28, 2001). Specifically, the data were obtained from Attachment 4, "Cost Analysis for GSI-191, Assessment of Debris Accumulation on PWR Sump Performance, Rev. 1" (September 12, 2001). Both the NRC memorandum and Attachment 4 are available in ADAMS. The memorandum Document Accession No. is ML012750091; the attachment Document Accession No. is ML012750414.

[9] Based on staff's best estimate.

The NRC assumes that all physical modifications will be performed in 2007 during normal outage periods. Therefore, no incremental reactor downtime or replacement energy costs were ascribed to these modifications.

#### 3.2.4.7 Audits and Inspections

The NRC anticipates that audits and inspections will be conducted in 2007 at a limited number of PWR plants to verify that licensees have resolved the concerns identified in the generic letter. For purposes of this analysis, the NRC estimates that 10 audits and inspections will be conducted. The NRC further estimates that 9.6 person-months of NRC Headquarters, 9.6 person-months of NRC regional staff time, and 9.6 person-months of contractor support will be required for this effort. Using an estimated average labor rate of $88 per hour for NRC staff and $157 per hour for contractor support, the NRC's cost for audits and inspections is estimated to be $532,800 (i.e., [3,200 hours x $88/hour] + [1,600 hours x $157/hour]).

### 3.2.5 Sensitivity Analyses

In estimating the quantitative values and impacts associated with Generic Letter 2004-02, the NRC staff conducted three sensitivity analyses. The first sensitivity analysis accounts for the uncertainty in the number of operating PWRs that will require physical modifications under the generic letter. For purposes of this analysis, the NRC adopted a low estimate of 25 PWRs and a high estimate of 37 PWRs. These estimates are based on work performed by Los Alamos National Laboratory (LANL) on GSI-191.[10]

The second sensitivity analysis accounts for variation in the cost for a reactor-specific modification. For purposes of this analysis, the NRC adopted a low estimate of $750,000 per reactor and a high estimate of $5 million per reactor (see Section 3.2.4.6).

The third sensitivity analysis accounts for the uncertainty in monetary value over time. In conducting this analysis, the NRC used discount rates of 7 and 3 percent to estimate the present value (in 2004 dollars) of the expected values and impacts. Discounting all costs to year 2004 adjusts for the fact that costs incurred at different points in time are not equivalent.

## 3.3 Results

Under the generic letter alternative (Option 2), NRC will require PWR licensees to (1) perform an evaluation of the ECCS and CSS recirculation functions, (2) implement any corrective actions (e.g., reactor-specific modifications) that the evaluation identifies as being necessary to ensure system functionality, and (3) submit information that confirms plant-specific compliance with the regulatory requirements outlined in the generic letter.

Using the cost assumptions discussed in Section 3.2 of this document, the NRC staff estimated the incremental costs to industry and the NRC under Option 2. These costs were estimated for the 25-PWR Case and the 37-PWR Case using the low and high-cost estimates for reactor-

[10] NUREG/CR-6762, "GSI-191 Technical Assessment: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance," dated August 2002. Available in ADAMS, Accession No. ML022470074.

specific modifications. All costs incurred in the future were calculated in 2004 dollars using discount rates of 7 and 3 percent. The benefits outlined in Section 3.2.3.2 were treated as negative costs. The results are presented in Tables 3 through 8 as follows:

- Table 3 provides the present value (in 2004 dollars) of the costs under Option 2 for the *low-cost* reactor-specific modification and *7 percent* discount rate.

- Table 4 provides the present value (in 2004 dollars) of the costs under Option 2 for the *low-cost* reactor-specific modification and *3 percent* discount rate.

- Table 5 provides the present value (in 2004 dollars) of the costs under Option 2 for the *high-cost* reactor-specific modification and *7 percent* discount rate.

- Table 6 provides the present value (in 2004 dollars) of the costs under Option 2 for the *high-cost* reactor-specific modification and *3 percent* discount rate.

- Table 7 is a summary of the present value (in 2004 dollars) of the costs under Option 2 for the *low-cost* reactor-specific modification.

- Table 8 is a summary of the present value (in 2004 dollars) of the costs under Option 2 for the *high-cost* reactor-specific modification.

As shown in Table 7, for the low-cost reactor-specific modification, the net present value under Option 2, using a 7 percent discount rate, is estimated to range from a cost of $2.4 million to a savings of $13.1 million. Using a 3 percent discount rate, the net present value is estimated to range from a savings of $50.0 million to a savings of $81.2 million. Thus, for the low-cost reactor-specific modification, the net present value under Option 2 is estimated to range from a cost of $2.4 million to a savings of $81.2 million.

As shown in Table 8, for the high-cost reactor-specific modification, the net present value under Option 2, using a 7 percent discount rate, is estimated to range from a cost of $89.1 million to a cost of $115.2 million. Using a 3 percent discount rate, the net present value is estimated to range from a cost of $47.2 million to a cost of $62.7 million. Thus, for the high-cost reactor-specific modification, the net present value under Option 2 is estimated to range from a cost of $47.2 million to a cost of $115.2 million.

Although the quantitative benefits do not outweigh the quantitative costs under Option 2 in all instances, NRC staff believes the expected qualitative values contribute substantially to the benefits of the generic letter. These qualitative values include (1) enhanced regulatory efficiency (by establishing a procedure that PWR licensees may use to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids), (2) improved understanding of ECCS and CSS recirculation capabilities at PWR facilities, (3) improved public health and safety, and (4) increased public confidence.

**Table 3**
**Present Value of the Costs Under Option 2:**
**Low-Cost Estimate for PWR Physical Modifications and 7% Discount Rate**[a, b]
(2004 dollars in millions)

| Category | 25-PWR Case[c] | | | 37-PWR Case[d] | | |
|---|---|---|---|---|---|---|
| | Costs to Industry | Costs to the NRC | Total Costs | Costs to Industry | Costs to the NRC | Total Costs |
| Offsite Health | ($11.0) | $0.0 | ($11.0) | ($14.4) | $0.0 | ($14.4) |
| Onsite Occupational Dose | ($0.8) | $0.0 | ($0.8) | ($1.0) | $0.0 | ($1.0) |
| Offsite Property | ($1.7) | $0.0 | ($1.7) | ($2.2) | $0.0 | ($2.2) |
| Onsite Property | ($62.3) | $0.0 | ($62.3) | ($81.1) | $0.0 | ($81.1) |
| Regulatory Activities | $0.0 | $0.7 | $0.7 | $0.0 | $0.7 | $0.7 |
| Evaluation Guidance | $0.3 | $0.4 | $0.7 | $0.3 | $0.4 | $0.7 |
| Research | $0.0 | $1.1 | $1.1 | $0.0 | $1.1 | $1.1 |
| First Response to Generic Letter | $2.2 | $0.1 | $2.3 | $2.2 | $0.1 | $2.3 |
| Second Response to Generic Letter | $57.2 | $0.5 | $57.7 | $57.2 | $0.5 | $57.7 |
| Physical Modifications[e] | $15.3 | $0.0 | $15.3 | $22.7 | $0.0 | $22.7 |
| Audits and Inspections | $0.0 | $0.4 | $0.4 | $0.0 | $0.4 | $0.4 |
| **Total** | ($0.8) | $3.2 | $2.4 | ($16.3) | $3.2 | ($13.1) |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.
[e] Assumes reactor-specific modifications will be implemented in 2007 at a cost of $612,223 per reactor.

**Table 4**
**Present Value of the Costs Under Option 2:**
**Low-Cost Estimate for PWR Physical Modifications and 3% Discount Rate**[a, b]
(2004 dollars in millions)

| Category | 25-PWR Case[c] | | | 37-PWR Case[d] | | |
|---|---|---|---|---|---|---|
| | Costs to Industry | Costs to the NRC | Total Costs | Costs to Industry | Costs to the NRC | Total Costs |
| Offsite Health | ($19.8) | $0.0 | ($19.8) | ($25.8) | $0.0 | ($25.8) |
| Onsite Occupational Dose | ($1.7) | $0.0 | ($1.7) | ($2.2) | $0.0 | ($2.2) |
| Offsite Property | ($3.0) | $0.0 | ($3.0) | ($3.9) | $0.0 | ($3.9) |
| Onsite Property | ($108.0) | $0.0 | ($108.0) | ($140.0) | $0.0 | ($140.0) |
| Regulatory Activities | $0.0 | $0.7 | $0.7 | $0.0 | $0.7 | $0.7 |
| Evaluation Guidance | $0.3 | $0.4 | $0.7 | $0.3 | $0.4 | $0.7 |
| Research | $0.0 | $1.1 | $1.1 | $0.0 | $1.1 | $1.1 |
| First Response to Generic Letter | $2.2 | $0.1 | $2.3 | $2.2 | $0.1 | $2.3 |
| Second Response to Generic Letter | $59.4 | $0.6 | $60.0 | $59.4 | $0.6 | $60.0 |
| Physical Modifications[e] | $17.2 | $0.0 | $17.2 | $25.4 | $0.0 | $25.4 |
| Audits and Inspections | $0.0 | $0.5 | $0.5 | $0.0 | $0.5 | $0.5 |
| **Total** | ($53.4) | $3.4 | ($50.0) | ($84.6) | $3.4 | ($81.2) |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.
[e] Assumes reactor-specific modifications will be implemented in 2007 at a cost of $686,356 per reactor.

**Table 5**
**Present Value of the Costs Under Option 2:**
**High-Cost Estimate for PWR Physical Modifications and 7% Discount Rate**[a, b]
(2004 dollars in millions)

| Category | 25-PWR Case[c] | | | 37-PWR Case[d] | | |
|---|---|---|---|---|---|---|
| | Costs to Industry | Costs to the NRC | Total Costs | Costs to Industry | Costs to the NRC | Total Costs |
| Offsite Health | ($11.0) | $0.0 | ($11.0) | ($14.4) | $0.0 | ($14.4) |
| Onsite Occupational Dose | ($0.8) | $0.0 | ($0.8) | ($1.0) | $0.0 | ($1.0) |
| Offsite Property | ($1.7) | $0.0 | ($1.7) | ($2.2) | $0.0 | ($2.2) |
| Onsite Property | ($62.3) | $0.0 | ($62.3) | ($81.1) | $0.0 | ($81.1) |
| Regulatory Activities | $0.0 | $0.7 | $0.7 | $0.0 | $0.7 | $0.7 |
| Evaluation Guidance | $0.3 | $0.4 | $0.7 | $0.3 | $0.4 | $0.7 |
| Research | $0.0 | $1.1 | $1.1 | $0.0 | $1.1 | $1.1 |
| First Response to Generic Letter | $2.2 | $0.1 | $2.3 | $2.2 | $0.1 | $2.3 |
| Second Response to Generic Letter | $57.2 | $0.5 | $57.7 | $57.2 | $0.5 | $57.7 |
| Physical Modifications[e] | $102.0 | $0.0 | $102.0 | $151.0 | $0.0 | $151.0 |
| Audits and Inspections | $0.0 | $0.4 | $0.4 | $0.0 | $0.4 | $0.4 |
| **Total** | $85.9 | $3.2 | $89.1 | $112.0 | $3.2 | $115.2 |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.
[e] Assumes reactor-specific modifications will be implemented in 2007 at a cost of $4,081,489 per reactor.

**Table 6**
**Present Value of the Costs Under Option 2:**
**High-Cost Estimate for PWR Physical Modifications and 3% Discount Rate**[a, b]
(2004 dollars in millions)

| Category | 25-PWR Case[c] | | | 37-PWR Case[d] | | |
|---|---|---|---|---|---|---|
| | Costs to Industry | Costs to the NRC | Total Costs | Costs to Industry | Costs to the NRC | Total Costs |
| Offsite Health | ($19.8) | $0.0 | ($19.8) | ($25.8) | $0.0 | ($25.8) |
| Onsite Occupational Dose | ($1.7) | $0.0 | ($1.7) | ($2.2) | $0.0 | ($2.2) |
| Offsite Property | ($3.0) | $0.0 | ($3.0) | ($3.9) | $0.0 | ($3.9) |
| Onsite Property | ($108.0) | $0.0 | ($108.0) | ($140.0) | $0.0 | ($140.0) |
| Regulatory Activities | $0.0 | $0.7 | $0.7 | $0.0 | $0.7 | $0.7 |
| Evaluation Guidance | $0.3 | $0.4 | $0.7 | $0.3 | $0.4 | $0.7 |
| Research | $0.0 | $1.1 | $1.1 | $0.0 | $1.1 | $1.1 |
| First Response to Generic Letter | $2.2 | $0.1 | $2.3 | $2.2 | $0.1 | $2.3 |
| Second Response to Generic Letter | $59.4 | $0.6 | $60.0 | $59.4 | $0.6 | $60.0 |
| Physical Modifications[e] | $114.4 | $0.0 | $114.4 | $169.3 | $0.0 | $169.3 |
| Audits and Inspections | $0.0 | $0.5 | $0.5 | $0.0 | $0.5 | $0.5 |
| **Total** | $43.8 | $3.4 | $47.2 | $59.3 | $3.4 | $62.7 |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.
[e] Assumes reactor-specific modifications will be implemented in 2007 at a cost of $4,575,708 per reactor.

**Table 7**
**Summary of Present Value of the Costs Under Option 2: Low-Cost Reactor-Specific Modification**[a, b]
(2004 dollars in millions)

| Discount Rate | 25-Plant Case[c] | | | 37 Plant Case[d] | | |
|---|---|---|---|---|---|---|
| | Industry Costs | NRC Costs | Total Costs | Industry Costs | NRC Costs | Total Costs |
| 7% | ($0.8) | $3.2 | $2.4 | ($16.3) | $3.2 | ($13.1) |
| 3% | ($53.4) | $3.4 | ($50.0) | ($84.6) | $3.4 | ($81.2) |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.

**Table 8**
**Summary of Present Value of the Costs Under Option 2: High-Cost Reactor-Specific Modification**[a, b]
(2004 dollars in millions)

| Discount Rate | 25-Plant Case[c] | | | 37-Plant Case[d] | | |
|---|---|---|---|---|---|---|
| | Industry Costs | NRC Costs | Total Costs | Industry Costs | NRC Costs | Total Costs |
| 7% | $85.9 | $3.2 | $89.1 | $112.0 | $3.2 | $115.2 |
| 3% | $43.8 | $3.4 | $47.2 | $59.3 | $3.4 | $62.7 |

[a] Table includes rounding error.
[b] Numbers in parentheses indicate savings rather than costs.
[c] Assumes 25 PWRs will require reactor-specific modifications.
[d] Assumes 37 PWRs will require reactor-specific modifications.

## 4. Backfit Analysis

Under the provisions of Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), the generic letter transmits a request for the purpose of verifying compliance with existing regulatory requirements. Specifically, the required information will enable the NRC staff to determine whether the ECCS and CSS at PWR facilities are able to perform their safety functions following all postulated accidents for which ECCS or CSS recirculation is required while taking into account the adverse effects of post-accident debris blockage and operation with debris-laden fluids.

Any reactor-specific modifications implemented by PWR licensees in response to the generic letter are necessary to bring the facility into compliance with its license or into conformance with written commitments by the licensee. Therefore, this regulatory action is an exception to the Backfit Rule, as provided at 10 CFR 50.109(a)(4), and thus a backfit analysis is not required.

## 5. Decision Rationale

For the two regulatory alternatives identified, the values and impacts have been considered. Although the quantitative benefits do not outweigh the quantitative costs under Option 2 in all instances, Option 2 was determined to be the preferred option because it is expected to (1) enhance regulatory efficiency (by establishing a procedure that PWR licensees may use to analyze the susceptibility of the ECCS and CSS recirculation functions to adverse effects of post-accident debris blockage and operation with debris-laden fluids), (2) improve the current understanding of ECCS and CSS recirculation capabilities at PWR facilities, (3) improve public health and safety, and (4) increase public confidence.

The NRC believes the incremental costs to licensees and the NRC under Option 2 are justified because the requested actions and information are necessary to verify plant-specific compliance with the regulatory requirements outlined in the generic letter and, thus, ensure adequate public protection.

## 6. Implementation

The regulatory action will be enacted through a generic letter to be issued prior to the end of 2004 (i.e., Generic Letter 2004-02). The NRC provided opportunities for public comment on this generic letter in the *Federal Register* on March 31, 2004 (62 FR 16980) and at several public meetings.

The generic letter will require addressees to (1) perform an evaluation of the ECCS and CSS recirculation functions, (2) implement any corrective actions (e.g., reactor-specific modifications) that the evaluation identifies as being necessary to ensure system functionality, and (3) submit information that confirms plant-specific compliance with the regulatory requirements outlined in the generic letter.

The timeframes for addressee responses to the generic letter were selected to (1) allow adequate time for addressees to perform an analysis; (2) allow addressees to properly design

and install any identified modifications; (3) allow addressees adequate time to obtain NRC approval, as necessary, for any licensing basis changes; and (4) allow for the closure of the generic issue in accordance with the published schedule. These timeframes are appropriate since all addressees have responded to Bulletin 2003-1 and will, if necessary, implement compensatory measures until the issues identified in the generic letter are resolved. No impediments to implementation of the recommended alternative have been identified.

The NRC currently is in the process of reviewing evaluation guidance developed by industry, and plans to issue a safety evaluation report endorsing some or all of the guidance, if found acceptable. Once approved, this guidance may be used to assist PWR licensees in determining the status of regulatory compliance.

The estimated resources entailed in this regulatory action are in the order of 9 full-time equivalent employees (FTEs). These resources will come principally from the Office of Nuclear Reactor Regulation (NRR), the Office of Nuclear Regulatory Research (RES), and the NRC regional offices. The estimated resources include the level of effort identified in the July 2004 NRR Director's Quarterly Status Report (DQSR) for planned actions on PWR sump performance and the additional level of effort required to review and process the information submitted under the generic letter:

NRR . . 8
Other . . 1